Higher Order Thinking through ICT: What do middle years teachers think really matters?

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The middle years of schooling has emerged as an important focus in Australian education. Student disengagement and alienation, the negative effects of non-completion of the senior years of schooling and underachievement have raised concerns about the quality of education during the middle years. For many schools, reshaping the middle years has involved incorporating Information and Communication Technologies (ICT) to motivate students. However, simultaneously there is a need to ensure that programs are academically rigorous. There is little doubt that there are potential benefits to integrating ICT into programs for middle years' students. However, little is known about how middle years' teachers perceive higher order thinking, which is a component of academic rigour. This paper investigates the question of *What are teachers' perceptions of higher order thinking in an ICT environment?* The study is underpinned by socio-cultural theory which is based on the belief that learning occurs through social interaction and that individuals are shaped by the social and cultural tools and instruments they engage with. This investigation used a collective case study design. Two methods were used for data collection. These methods are semi-structured interviews with individual teachers and a class and a focus group discussion with teachers. Findings indicate that teachers hold various perceptions of higher order thinking that lead to productive approaches to integrating ICT in middle years' classrooms. The paper highlights that there may be a continuum of perceptions of higher order thinking with ICT. This continuum may inform professional developers who are guiding and supporting teachers to integrate ICT into middle years' classrooms.

Keywords: Education in the middle years and the middle years of schooling

INTRODUCTION

The middle years of schooling has emerged as an important focus in Australian education. Student disengagement and alienation, the negative effects of non-completion of the senior years of schooling and underachievement have raised concerns about the quality of education during the middle years (Batten & Russell, 1995; Cormack & Cumming, 1996; Lingard et al., 2001). For many schools, reshaping the middle years has involved incorporating Information and Communication Technologies (ICT) which motivate students (Bursey & Newhouse, 2004). However, simultaneously there is a need to ensure that programs are academically rigorous. There is little doubt that there are potential benefits to integrating ICT into programs for middle years' students (Schacter & Fagnano, 1999; Wegerif & Dawes, 2004). However, little is known about how middle years' teachers perceive higher order thinking, which is a component of academic rigour. This paper investigates the question of *What are teachers' perceptions of higher order thinking in an ICT environment?* Perceptions are notions, impressions or ideas about something. To provide a background for this investigation, this paper presents a brief overview of higher order thinking, ICT in education, and the role of social interactions in learning.

BACKGROUND

Higher order thinking is an important element of academic rigour (Braxton & Nordval, 1985; Graham & Essex, 2001; Lingard et al., 2001; Resnick & Helquist, 1999). However, higher order thinking is variously described in the literature. For example, the taxonomy of learning objectives developed by Bloom (1956) denotes thinking skills as comprising knowledge, comprehension, application, analysis, synthesis and evaluation. These processes are considered to be cumulatively hierarchical with the latter three skills generally seen to constitute higher order thinking. Anderson and Krathwohl (2001) revised Bloom's original taxonomy adding the ability to create new knowledge at the highest level of the hierarchy. Other theorists (Marzano, 1992; Newmann, 1990) highlight thinking dispositions and attributes as factors that impact on a student's ability to think and learn. This philosophy underpins Marzano's (1992) model of thinking, called the *Dimensions of Learning*. His model uses a hierarchy of thinking skills similar to Bloom's taxonomy but also acknowledges the important role that attitudes, perceptions and mental habits play in higher order thinking. Thus, higher order thinking incorporates a broad range of attributes. To accommodate these various perspectives on higher order thinking, I have adopted the following definition by Lingard et al., (2001):

> (Higher order thinking) occurs when students manipulate information and ideas in ways which transform their meaning and applications. This transformation occurs when students combine facts and ideas in order to synthesise, generalise, explain, hypothesise or arrive at some conclusion or interpretation. When students manipulate information and ideas through these processes they solve problems and discover new (for them) meanings and understandings. (pp. 18-19)

The implication of this inclusive view of higher order thinking for teaching, learning and assessment is that a variety of attributes and cognitive processes need to be considered and fostered as students learn.

The past decade has seen substantial growth in the use of ICT for teaching and learning. The use of ICT is appropriate for middle years' students because it can lead to enhanced student engagement and achievement when teachers use it effectively (Schacter & Fagnano, 1999; Wegerif & Dawes, 2004). However, for teachers to be able to maximise the potential afforded by ICT, they need to view it as affording cognitive opportunities and have specific ICT and pedagogical expertise. Jonassen (2000) proposed that when teachers view computers as mindtools, they begin to engage learners in higher order thinking: "Mindtools are computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner, in order to engage and facilitate critical thinking and higher order learning" (p. 9).

According to Vygotsky (1987), individuals benefit from using tools in two ways. First, tools are used to mediate activity and fundamentally change all psychological operations. Hence, there is opportunity for learning through the use of tools. Second, the use of tools, in conjunction with social interaction with more capable peers or adults, mediate higher mental processes thereby triggering greater cognitive engagement than by themselves. In such an environment, learning occurs when a less capable individual is scaffolded by a more capable individual during social interaction and internalises the effects of working together. Hence, ideally learners should have opportunities to work and learn together.

Thus, the purpose of this study is to investigate teachers' perceptions of higher order thinking in the context of teaching, learning and assessment in middle years' ICT enriched learning environments. Limited research has been conducted into teachers' perceptions or beliefs about teaching, learning, higher order thinking and technology (Becker, 1994; Ertmer, Gopalakrishnan & Ross, 2001). However, if educators are to understand how to assist

teachers achieve productive, high-level use of ICT in classrooms they need to examine teachers and the perceptions or beliefs they hold about teaching, learning and technology (Ertmer, 2005).

DESIGN AND METHODS

This investigation used a collective case study design (Merriam, 1988; Stake, 1995). Two methods were used for data collection. These methods were semi-structured interviews with individual teachers and a class and a focus group discussion with teachers. The use of multiple methods (Flick, 1998) was appropriate because it "adds rigor, breadth, complexity, richness, and depth to any inquiry" (p. 231). A case study database was developed to organize and store the data. Data were coded and categories were developed from the analysis of the data to aid in the development of explanations and interpretations.

The study was conducted in Queensland with six teachers from a middle schooling cluster that had participated in a one to two year professional development program. Each of the teachers was interviewed about their perceptions of higher order thinking. A class interview in the form of a discussion was also conducted with sixteen Year 6/7 students that had participated in the study. A focus group was also held with five of the six teachers. Throughout this paper, teachers are referred to by their pseudonyms or the first letter of their pseudonym. These are Alice (A), Bella (B), Clare (C), Daisy (D), Emily (E) and Faith (F). The letter I is used in excerpts of transcripts to denote the interviewer who is the researcher. Alice, Bella and Clare were primary school teachers and the other three were high school teachers. Clare was the only teacher who did not participate in the focus group interview and a group of students from Alice and Clare's classes was interviewed.

FINDINGS

Higher order thinking is perceived to be an element of academic rigour by the six teachers as is evidenced by their inclusion of it in their group definition of academic rigour. This definition was constructed during the focus group discussion using a draft which I developed from teachers' individual definitions.

> Group Academic rigour is engaging students in authentic learning situations that challenge and motivate them. It represents a standard of expectation, quality and engagement and is focussed on what is important. It requires teachers and students to expand their knowledge and understandings of concepts which relate to the world around them. Academic rigour incorporates academic engagement, the application of knowledge, ways of working and the development of higher order thinking. (Focus Group)

Three key themes about higher order thinking were evident in the data as teachers discussed their perceptions of academic rigour during individual interviews. The first theme focuses on teachers' perceptions of higher order thinking. The second theme emphasises that using ICT affords opportunities for higher order thinking. The third theme relates to the socio-cultural contexts that support thinking when using ICT.

Theme 1: Teachers' perceptions of higher order thinking

Although the group agreed that academic rigour incorporates the development of higher order thinking, two distinct perspectives about higher order thinking emerged from the data. One perspective is that *thinking is hierarchical*, and the other was *less explicit about levels of thinking and placed greater emphasis on time and effort for thinking.*

Thinking is perceived to be hierarchical by four teachers (C,D,E,F). Three teachers (C,D,F) referred to "higher order thinking" or "higher level thinking" in the group of words

they used to describe academic rigour. The fourth teacher (E) used the words "looking at things in new ways" and thinking on a "whole new level". These four teachers mentioned levels of complexity in thinking processes. For example, Clare referred to thinking processes, including "simple knowledge basically to more complex, like analysing". Emily indicated that she thought the kind of thinking required of students in primary school was not rigorous enough for what is required in high school. She sees the role of the high school teacher as requiring students to challenge their thinking as is exemplified in the following excerpt.

> Emily We should shift the mentality they have from the primary school and step them up and start thinking about things on a whole new level because at the moment some of them are still thinking in that basic primary school terms and ideas and trying to get them to step up and challenge themselves. (Interview 1)

However, Emily not only emphasised getting students to think on a higher level, she also stressed getting students to put in the effort to "go that extra yard".

In contrast to the other three teachers, Faith described a holistic approach to thinking and learning that requires students to be constantly challenged in their thinking taking their thinking to a new level. She elaborated on her perception of the importance of higher order thinking when remarking that rigorous assessment is that which "requires the students to come in on a level, apply their learning and thinking to it and go to another level sort of thing so again it would have a level of complexity in it and students would have to use that higher order thinking element of that". Faith emphasised the need to develop students' thinking. She perceives this to be central to all learning experiences that they should be engaging with. This approach to thinking is further exemplified by Faith's description of what contributes to academic rigour which was shared during her first interview.

> Faith I would have to say that the learning experiences and by that I mean the structure of the learning experiences so they need to be built around thinking and by that I mean the way that it's probably taught and modelled so it's not just a one step thing, the kids are modelled explicitly to thinking skills around that and then I think the standard of depth of the learning experiences or the assessment task. (Interview 1)

Alice and Bella *were less explicit about the levels of thinking and placed greater emphasis on time and effort for thinking.* Although they made very few explicit references to thinking, they did indicate that students need to engage in tasks that incorporate various skills and processes that require time and effort to complete and that are not totally dependent on one skill such as writing. Alice explained that this means that students can't just "breeze through a task and come to you within five minutes and say I'm finished and [they] haven't even thought about it". Although neither Alice nor Bella used the words "higher" or "level" in relation to thinking they both seem to perceive that students need to engage in thinking that is hard or requires effort. For example, Alice refers to extending students by making them think. The following excerpt, from the class discussion with Alice's Year 6/7 students in which I asked them what they had learned in doing their project tasks, demonstrates clearly that the students were challenged in their thinking. The two students are identified by the letters K and O.

Student K	Yeah, we got the information and we put it in our own words.
I	Okay, Yes
Student O	It had to have a scientific backing behind it like if you did sport you had to report on an injury to someone. You had to talk about their ligaments and their muscles and their tissue and everything.
I	So you had to show that you understood the science part of it?
Student O	Yeah
I	Right. Was that hard, was that an interesting part or what did you think of that?
Student O	It was hard.

In contrast to Alice, Bella does refer to students being able to identify and explain underlying concepts. On occasions she seems to equate the results of putting in effort with more complex thinking. However, she wrote the word "effort" on her list of descriptors of academic rigour rather than thinking. Furthermore, she included a focus on tasks "that require both time and effort to complete" in her definition of academic rigour.

Clearly, the two groups of teachers place different emphasis on what constitutes the kind of thinking they deem to be important for academic rigour. The first group of teachers explicitly referred to thinking as being hierarchical with some types of thinking incorporating greater cognitive demand than others (C,D,E,F). In contrast, the other two teachers made little mention of levels of thinking and focussed more on the circumstances of time and effort for thinking (A,B). However, these two teachers also view thinking as having degrees of complexity, indicating that they also perceive it to be hierarchical. The different degree of explicitness about thinking expressed by these teachers suggests that they may take different approaches to how they perceive and foster thinking in the classroom. It may also have implications for how the teachers engage students with ICT in the classroom.

As a group, the teachers agreed that they perceive thinking to be hierarchical, nominating higher order thinking as being important for academic rigour. This finding, in part, aligns with research by Graham and Essex, (2001). They found that university faculty members and graduate assistants at a USA major Midwestern state university incorporate critical thinking in their definitions of academic rigour. There is, however, some confusion in the literature about the differentiation between critical thinking and higher order thinking but there is general agreement that both can be distinguished from basic thinking skills (Lewis & Smith, 1993). One plausible explanation for why the teachers in my study used the term "higher order thinking" rather than "critical thinking" may be because the former term is used in professional development resources which were provided to teachers who participated in the research.

Theme 2: Affordances of ICT for fostering higher order thinking

ICT is perceived to afford opportunities for higher order thinking by the six teachers. This assertion is supported by the fact that during the focus group the teachers agreed that a range of strategies associated with higher order thinking were important for ensuring academic rigour when students used ICT. The teachers referred to using complex skills; complexity and depth; modelling, structuring and scaffolding thinking processes; and problem solving when students used ICT. These comments clearly demonstrate that teachers perceive that ICT affords higher order thinking.

An analysis of teachers' individual interviews highlighted their views that ICT can foster greater on-task behaviour and can provide opportunities for higher order thinking when its use is integral to challenging tasks. However, two perceptions on integrating ICT in a manner which provides opportunities for higher order thinking emerged from the data. One perception focussed on *fostering thinking through experiences with ICT* and the other emphasised *using ICT to engender greater effort for thinking.*

Fostering thinking through experiences with ICT was emphasised by four of the teachers (C,D,E,F). They focussed on specific uses of ICT which foster and support thinking. For example, Daisy referred to students using the computer to generate diagrammatic representations of information. Organising and presenting the information graphically frees up mental resources for and supports higher level thinking, such as making comparisons and drawing conclusions. Emily indicated that she thought the computers facilitated the application and linking of concepts enabling students to explore topics more deeply. Clare emphasised the opportunities provided by ICT for higher order thinking. However, in contrast to the other teachers Clare also emphasised that ICT "and all the difficulties that you experience with technology" present real life problems that provide opportunities for students to engage in and practice problem solving. She indicated that when working with her students she "never gave them an answer" and "never fixed a problem". Instead she asked them questions, such as "How are we going to overcome this?" and "Who are you going to talk to to get more memory". Clare saw the problems as shared problems that could be used to develop students' "lifeskills".

In contrast to the other three teachers (C,D,E) who emphasised how specific uses of ICT provides opportunities for deeper thinking, Faith described a holistic approach to integrating ICT in a manner which fostered thinking. She suggested that although students need to have an opportunity to engage in a variety of skills and processes when using ICT this does not necessarily create academic rigour. She indicated that the rigour comes from "where they're engaging the thinking" and suggested that this means that there should be a level of complexity. She outlined a holistic approach to integrating ICT which begins "when teachers are looking at their task design" and extends through to "the end point" of the task. She said that teachers need to look at what thinking processes are engaged, including those prescribed in the syllabuses. Faith suggested that teachers should then "model out the thinking processes and [then make sure] that that is structured and scaffolded in the task". She explained that when ICT is integrated, teachers need to make sure "that with all the alignment that it's not just the one step process so there's some depth to it".

Using ICT to engender greater effort for thinking through integrating ICT in challenging tasks was referred to by Alice and Bella. They indicated that ICT needs to be integrated so that students are getting the best out of them. However, unlike Clare, Daisy, Emily and Faith these teachers primarily emphasised an approach to using ICT that exploits the enthusiasm and effort that it engenders. They explained that students' interest in using ICT gives them a reason to put greater effort into more components of their task including those elements that may be less interesting or more difficult. During the focus group discussion, Alice said that ICT was a "massive motivation" for the students in her class. Her students' enjoyment of ICT was evident in their reflections on their tasks as is highlighted in Student A's comments on her self evaluation form when responding to the question about what she enjoyed most about the task.

> Definitely the filming. I really liked learning to use the video camera. I also liked editing the movie on Windows Movie Maker. I enjoy using the computer and we got to do heaps of cool stuff in Movie Maker. (Alice's 6/7 class, Student A, Project task)

Similarly, Bella indicated that incorporating ICT in challenging tasks engenders effort and encourages greater on-task engagement. However, in contrast to Alice rather than emphasising engagement with pre-requisite written elements of a task, Bella highlighted how the enjoyment of using ICT promotes/fosters enthusiasm, effort and persistence. She sees these dispositions or behaviours as particularly important for sustaining engagement with challenging and complex tasks. In describing how ICT was used by her students during the project task, Bella described students who were "keen" and "responsible". Bella highlighted

how her students were exploring and inquiring with computers as well as enjoying teaching the teacher and other students.

These findings highlight two groups of teachers' perceptions of higher order thinking. The first group (C,D,E,F) focussed on the way in which ICT is used, drawing upon the capabilities of the ICT tools and resources to enable higher order thinking. The second group of teachers (A,B) put a greater emphasis on using ICT to motivate and stimulate students' interests thereby fostering effort and persistence for sustained engagement in thinking and learning experiences. Both groups of teachers translate their perceptions of higher order thinking with ICT to productive uses of ICT in teaching, learning and assessment in middle years' classrooms. The teachers seemed to perceive that ICT presents a range of affordances for fostering and supporting higher order thinking in middle years' classrooms. This finding is informative because there is very limited previous research in this area as earlier studies have generally focussed on student motivation or achievement when using ICT; specific thinking skills programs; or particular computer software programs rather than teachers' perceptions (Harlen & Crick, 2003; Wenglinsky, 1998). Although some previous studies address teachers' knowledge of thinking, very limited research has been done on teachers' professional knowledge or perceptions about teaching thinking (Zohar & Schwartzer, 2005), when using ICT in teaching, learning and assessment.

Theme 3: Socio-cultural contexts that support thinking when using ICT

Sharing and discussing strategies with peers and others was identified by the group of teachers as a strategy that is important for ensuring academic rigour when using ICT. However, an analysis of transcripts of the first individual interviews identified that teachers place varying levels of emphasis on students sharing and discussing with their peers in the socio-cultural contexts of their classrooms. Two perceptions emerged from the data. One view focuses on *fostering higher order thinking processes as students work independently or with teacher guidance as they learn with ICT*. The other perception emphasises that *ICT provides a shared focus for collaboration and social thinking.*

Fostering higher order thinking processes as students work independently or with teacher guidance as they learn with ICT was the primary focus of three of the teachers (D,E,F). For example, Emily suggested that it's important to build on what students know "stepping it up and showing them how to use different components of the program so that they can be successful with what they're doing". Daisy indicated that this involved the teacher explaining and sometimes physically showing students how to use software and hardware. She referred to academic rigour as being "a combination of knowledge of content, integration of ICT, hands on experience and application of the knowledge to tasks that lead to higher order thinking within the students". Similarly, Faith emphasised individual learning contexts rather than collaboration in describing an example of higher order thinking.

> Faith There was good ICT integration, it was a functional level of integration but the whole time the kids had to be working scientifically the whole time, they had to be thinking about the processes, thinking about what was going on, drawing conclusions and their level of thinking in that task was showing through right to the end so I think that was a good example. (Interview 1)

Overall, these three teachers emphasised the role of the teacher rather than student collaboration when referring to fostering higher order thinking.

ICT provides a shared focus for collaboration and social thinking according to the other three teachers (A,B,C). They referred to social contexts which included whole class and small group discussions with students learning from one another. Exploring and learning with ICT was seen to afford particular opportunities for students to teach one another, discuss new

ways of doing things and engage in social thinking. The teachers themselves modelled shared thinking and encouraged the students to do the same. For example, Clare said the teachers "got together and did our own assessment task and got the kids to assess us according to the criteria sheet that we gave them". This activity was used to clarify expectations as well as stimulate student thinking. This kind of social thinking and collaboration was often referred to in relation to students being focused around a shared task, digital camera, video or computer screen. Students were also encouraged to try things out. Bella indicated that when students use ICT talking "with their peers, is the best way just to make it interesting for them rather than having the teacher say, 'now do this, now do that and don't do this'.

The two groups of teachers presented different perceptions of the kind of social and cultural contexts that foster higher order thinking when ICT is used in teaching, learning and assessment. Although all teachers appear to perceive ICT as affording opportunities for higher order thinking, they clearly emphasise different approaches. The first group (D,E,F) indicated that ICT needed to be used as a cognitive tool or mindtool stressing individualised approaches to thinking and learning which aligns with findings from previous research (Jonassen, 2000). In contrast, the other teachers (A,B,C) suggested that ICT was an interactive technology which could provide socio-cultural contexts to foster social thinking and contribute to learning conversations This perception also aligns with the literature (Roschelle et al., 2000; Vygotsky, 1978).

DISCUSSION

In summary, there are three types of perceptions about higher order thinking through incorporating ICT in teaching, learning and assessment. The first perception was that higher order thinking was hierarchical and could be fostered as individuals learn with ICT. This view was held by three teachers (D,E,F). These teachers focussed on the affordances of ICT as stemming from specific uses which enable higher cognitive processes. Fostering higher order thinking processes as students work independently or with teacher guidance as they learn with ICT was the primary focus of these three teachers.

The second perception was that thinking is multifaceted and requires time and effort which can be fostered by ICT. Two teachers (A, B) shared this perspective and were less explicit about levels of thinking but placed greater emphasis on influencing students' disposition to think. However, they did suggest that thinking could involve differing levels of complexity. Consequently, they put greater emphasis on using ICT to motivate and excite students' interest. They focussed on using ICT to engender effort and persistence for sustained engagement in thinking and learning. They perceive ICT as an interactive technology which fosters social thinking and learning conversations.

The third perception of higher order thinking in middle years' classrooms incorporating the use of ICT was that this environment presents opportunities for real life problem solving and decision making. This view was held by Clare. Her perception incorporates a combination of elements expressed by the previous two groups of teachers. Similar to Alice and Bella, she perceived that ICT provides a shared focus for collaboration and social thinking. Like the other three teachers (D,E,F), Clare perceived thinking to incorporate various levels and complexity. However, in contrast to all others she also emphasised that the difficulties that students experience as a result of the nature of ICT present additional opportunities for practicing problem solving and decision making. A plausible explanation for Clare's different perspective may stem from her espoused confidence and expertise in using computers (Becker, 1994).

CONCLUSION

Although this investigation does not claim to be exhaustive, it does provide insight into teachers' perceptions of higher order thinking as they integrate ICT in teaching, learning and assessment in middle years' classrooms. Limited previous research has explored teachers' understandings of teaching, learning, and ICT (Becker, 1994; Ertmer, Gopalakrishnan & Ross, 2001). In addition, previous research has primarily focused on exemplary computer-using teachers and constructivist approaches rather than teachers with a small amount of engagement in targeted professional development and their perceptions of higher order thinking (Becker, 2000). A limitation of previous research, acknowledged by Becker, is that it may be difficult to extend lessons learned from exemplary computer-using teachers to teachers without deep interests or backgrounds in technology. My study differs from the existing literature because it reports on the perceptions of teachers who are undertaking professional development to enhance their knowledge and skills. In addition, given the importance of higher order thinking for effective use of ICT, insight gained through this study into how teachers' perceive higher order thinking through ICT also adds to the literature. This finding is of particular note because when teachers perceive computers as tools that facilitate higher order thinking they begin to engage learners in more productive high level uses of ICT (Jonassen, 2000; Roschelle et al., 2000; Wenglinsky, 1998).

Teachers' perceptions of higher order thinking in the context of using ICT in classrooms appear to exist on a continuum. This continuum seems to extend from perceptions of higher order thinking for individualised learning to collaborative approaches to fostering higher level thinking through social contexts as students use ICT. At the other end of the continuum teachers embrace what may be seen as difficulties in using the technology itself, perceiving these as opportunities for practicing higher order thinking in real life situations. Instead of seeing the difficulties related to using ICT as obstacles, teachers could be encouraged to embrace these occasions as opportunities for students to engage students in real life problem-solving and decision making skills.

Continuum of higher order thinking with ICT

Individuals use higher order thinking as they engage with challenging tasks using ICT, independently	Individuals use higher order thinking as they engage with challenging tasks using ICT, accompanied by challenging questions from the teacher	Individuals use higher order thinking as they engage with challenging tasks using ICT, with peer support and accompanied by challenging questions from the teacher	Students use higher order thinking as they engage in collaborative challenging tasks using ICT, accompanied by challenging questions from the teacher and/or others	Students engage in collaborative, challenging tasks which involve group decision making, accompanied by challenging questions from the teacher and/or others	Students engage in collaborative, challenging tasks accompanied by challenging questions from the teacher and/or others with real life problem-solving and decision making as an integral part of using ICT

This continuum may provide a useful tool for teachers as they look to enhance their use of ICT in teaching, learning and assessment. It may also inform professional developers who are guiding and supporting teachers to integrate ICT into middle years' classrooms. Professional dialogues about perceptions of higher order thinking through the use of ICT could enhance understandings of productive strategies for fostering higher order thinking. This approach offers potential benefits to teachers in enabling them to more fully exploit the affordances of ICT for engaging students, both independently and in groups, in academically rigorous programs in the middle years.

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